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COMMERCIALIZATION OF RESEARCH RESULTS - GOVERNMENT POLICY OF KOREA*

by

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Commercialization of research results is of immense interest to the Korean Government since the effectivensess of the Government's support system can ultimately be measured by the degee of commercialization resulted from all the R&D* efforts. Although the Government does maintain some laboratories such as National Industrial Research Institute, the role of Government is more strongly felt through many of the measures and policy guidance to encourage the development efforts of the private industry, the semigovernmental research institutes and university community.

1. Government Policy to Promote Technology Development

A. Promotion of R&D by Tax Reduction

In the center of these policy measures is the Technology Development Promotion Law which was promulgated in 1972.
Under this law, the Government provides various tax incentives and financial support.
This is a system whereby the industry can set aside either up to 30% of profit or 1.5% of sales for research and development, and this technology development reserve fund, when used in either R&D or modification of imported technology within four years, is exempted from taxation.

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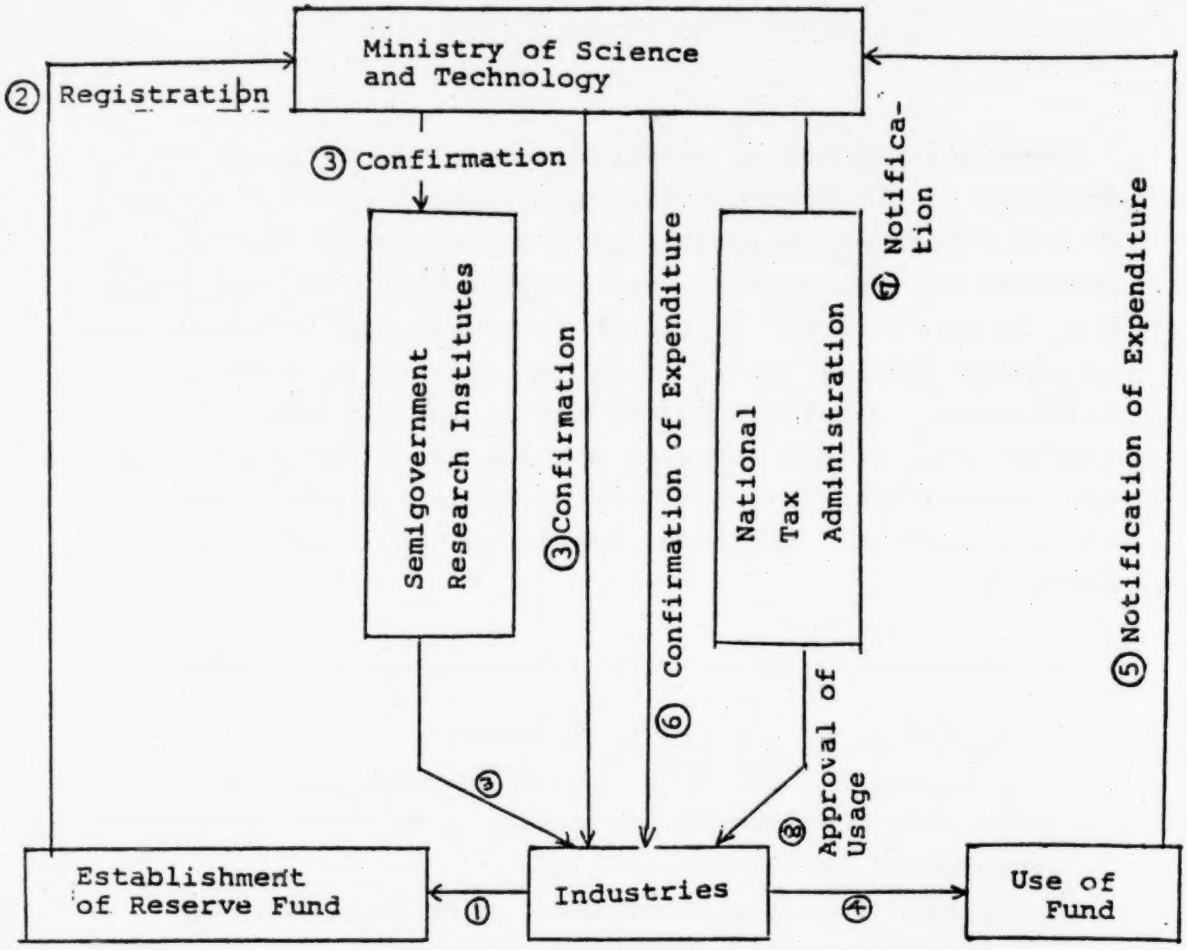
* Research and Development

Approval system for the technology development reserve fund is depicted below.



Under this system, the industry has the option of using the fund for their own research activities as well as to fund research projects at various national laboratories established with the endowments of the government but run autonomously (semigovernment research institutes).
The fund can be used not only for straight R&D but also for;

- Digestion and improvement of imported tedhnology,
- Acquistion of Technical information,
- Technical training and invitation of experts,
- Patent related activities, and
- Extablishment of development associations.

The fund therefore can be utilized for broad range of commercialization efforts.

Other policy measures for encouraging R&D activities are the tax exemption systems which can be summarized as follows.

- Reduction of corporation tax for the amount of up to 10% of investment in R&D and the training of technical manpower.

- Exemption of acquisition tax, property tax, registration tax for the estates acquired for R&D purposes by a company which has independent R&D facilities with more than 30 members of research staffs.

- The exemption of special consumption tax for the luxurious parts imported as samples for R&D purposes.

- Tax exemption up to 10% of investment or grant of special depreciation up to 50% of investment spent for purchasing machinery and equipment by a new venture utilizing domestically developed technologies.

- Reduction of special consumption tax up to 90% during first four years to expand domestic market for the items leading the technology development.

- Exemption of entire tax for the first 5 years on the income originated from licencing patent or sale of Know-how to a domestic entrepreneur, and reduction of income tax up to 50% when provided to foreign entrepreneur.

- Exemption of tax on the income from engineering services made during the first five years.

- Exemption of income tax for the foreign technical experts.

- Tax exemption for the capital gain originated from sales of stocks held by a venture capital company.

B. Financial Support for the R&D and Commercialization Activities.

Although the Government has enacted the Technology Promotion Law to assist all the development activities in Korea, the Ministry of Science and Technology (MOST) also decided to emphasize some high technology areas as prime area of concern for future growth of Korean economy. Areas emphasized are;

- Semiconductors and Computers,
- Specialty Chemicals,
- Upgrading of Machinery Industry,
- Energy and Resources Utilization,
- Systems Industry,
- Bioengineering Industry,
- Materials Industry,
- Textile and Polymer Industry,
- Construction/Environment/Plant Engineering.

R&D in these specified fields when undertaken by private industries can receive varying degrees of government fund which can be paid back within 5 years after commercialization.
Small and medium industries can receive up to 70% of required fund through careful screening processes in consideration of the high risk burden in the early stage of R&D.
Beside these industry-led projects, the Government can also provide fund for government-led, large scale and mission-oriented basic research projects in these fields.

Funds allocated for these efforts are sizable and contibuted greatly in stimulating R&D in Korea.
The increasing trend in resource allocation to the R&D activities in recent years in outlined as in the following table.

* Investment in Government-Industry Co-sponsored R&D projects

	'82	'83	'84
o R&D investment			
o Government	$16.7mill	$27.5mill	$27.5mill
o Private industry	$ 6.8mill	$15.6mill	$16.3mill
o No.of Participants	86	131	150
o No.of Researchers Involved	2,263	3,232	3,500
o No.of R&D Subjects	125	182	148

As a result of the continued support to the R&D related activities, a number of R&D results have been successfully commercialized in recent years. Typical projects among the successful ones are:

- Base material for semiconductor lead frame
- Mini-computer for education
- Medicine for distoma
- NMR-CT(Nuclear Magnetic Resonance Computer Tomography) for medical use.

C. Other Support for R&D promotion

Besides above financial support, the Government recommends large scale companies to establish their own research institute while small and medium companies are advised to organize research consortiums for their common areas for research.

Tax privileges and government funds have been extended to private research institutes as well as government funded

research institutes for carrying out nationally prioritized projects. Morever, researchers at private research institutes are allowed the same military conscription exemption as those at government funded institutes in order to facilliate securing and enlarging the research staffs for the private institutes. And researchers are compensated for their research efforts in the form of an incentive which is normally a proportionated portion of licensing and royalty income originated from their research results. At present, there are 129 private research institutes and 18 research consortiums in Korea.

On the other hand, small and medium industries, regardless of whether they were established from successful R&D results or not, are expected to confront with many technical problems which are usually not detected in the R&D stages or in routine operation.

Thus, in order to reinforce problem solving ability for the small and medium industries, technical consultation service by researchers and the dissemination of latest technological information are provided by the Industrial Technology Development Center (ITDC) attached to Korea Institute of Machinery & Metals (KIMM) with its highly sophisticated staffs and abundant technological information.

In addition, a technology assistance system by qualified researchers from government funded research institutes is being expanded for small and medium industries.

At the same time, financial supports from such financial organizations as Small and Medium Industry Bank(SMIB),

Korea Longterm Credit Bank (KLB), venture capital companies, Korea Credit Guarantee Fund (KCGF), Korea Development Bank (KDB), and Small and Medium Industry Promotion Corporation (SMIPC) are available for the industry in the fields of the establishment of business venture, acquistion and erection of R&D facilities, installation of facilities for training technical manpower, import of technology and digestion of imported technologies.

2. Venture Capital and Venture Business

Another promotional measure which the Government can enact to stimulate the commercialization of R&D results is the establishments of venture capital fund and organizations. In 1983, the Government authorized the financial and insurance companies to utilize the Technology Development Promotion Law to establish venture capital companies. Under this arrangement, companies can claim tax exemption when they invest in venture capital company. In 1984, the Government has decided to increase the capital of KTDC and K-TAC as a part of this plan. MOST also has decided to increase the New Technology Based Company Formation Fund from 1.4 million dollars 2.5 million dollars in 1984.

Venture capital company provides financial support for:

1) industry's in-house R&D activities and contracts with research institutes,

2) the first commercial exploitation of R&D results and direct or indirect investment in R&D,

3) technology transfer fees, improvement and digestion of advanced foreign technologies,

4) introduction of advanced foreign engineering technology, development and promotion of local engineering capabilities. So far, four venture capital companies have been established in Korea and they are outlined as in the following table.

* Venture capital companie in Korea

	K-TAC	KTDC	KDIC	KIFC
Establishment	1974	1981	1982	1984
Capital	$2.0million	$19.0million	$8.5million	$12.5million
Shareholders	KAIST	Government, Private industries	Short term credit financial companies, IFC	KDB
Main Function	.Commercial promotion of new R&D results .Investment in new commercialization projects.	.Sales of Know-How .Investment in R&D projects	.Investment, financing for new and expansion projects	Same as KDIC

In general, the venture capital company offers financing in the form of

1. conditional loan which is repaid on a royalty basis in proportion to sales amount if the project is succeeded in business and if it fails, only a small portion of the principal is recovered,

2. Equity participation in a new venture as requested by an enterprise for alleviating cost of money,

3. Providing loans on credit basis to the companies with promising technology but without proper collateral for financing new projects,

4. Conventional loans as those offered by commercial banks.

Such financial support for technology development by the banks and venture capital companies increased from 92.5 mill. dollars in 1982 to 194.4 mill. dollars in 1983.

The financial support made by KTDC, which is a typical venture capital company in Korea, is analyzed in the two separate viewpoints as in the following tables.

1) Financial support by commercialization stages

Unit:million dollars

Steps	'81	'82	'83
. R&D	7.4	22.9	40.8
. Commercializing of R&D results	0.1	3.1	9.5
. Acquisition of R&D facilities	0.1	1.6	12.1
Total	7.6	27.6	62.4

2) Financing record by loan type

Unit : million dollars

Type	'81	'82	'83
Venture capital			
. conditional loan	0.6	2.3	1.3
. equity investment	0	0.4	1.3
. loan on credit	2.6	10.8	37
Sub total	3.2	13.5	39.6
. Conventional loan	4.4	14.3	22.9
Total	7.6	27.8	62.5

The Ministry of Finance is also planning to establish the over-the-counter stock market to channel venture-oriented fund to new venture projects. Such kind of governmental efforts, if successful, attract valuable funds which otherwise may not be used for industrial development.

The problems in implementing such plans, however, deserve some attention. For example, Korea at this time needs to have more commercializable R&D results that are ready for immediate input of funds. We also need to create an environment such that young entrepreneurs in large industry can take the risk of creating new ventures.

Several measures can be taken to alleviate the situation. These are;

1. Creation of favorable environment by easing the conditions of entering the stock market for high-tech companies

2. Establishing a law enabling the use of various pension funds to be used by investment companies.

3. Allowing the investment trust companies to invest in venture capital companies.

4. Establishments of additional venture capital companies by private industries and banks.

5. Organized effort to provide more investment opportunities to potential investors.

3. Conclusion

The Government policies however must be well administered to yield desired results. The domestic development also should be balanced with careful technology transfer from abroad.

In Korea, the induced technologies have played a vital role in its industrialization process during the 1960s and 1970s.

For the last several years technology inducement has increased rapidly with the royalty payments going up to us $150million in 1983.

Since the trend at present is an open door policy for foreign investors who want to invest in Korea.

The Government in 1980 adopted an automatic approval system to facilitate the technology transfer from abroad in virtually all industrial fields. Furthermore, in 1984, the Government changed the approval system to a report system to make the technology inducement faster and more efficient. It is believed that this policy will ultimately strengthen Korea's R&D capability.

But concurrently, Korea will continue to nurture domestic effort to create and adapt new technology which is so vital to the future development of Korea. We hope this brief outline of Korean experience will be of help to our friends who may face similar problems.

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COMMERCIALIZATION OF RESEARCH AND DEVELOPMENT RESULTS - KOREAN EXPERIENCE*

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Young-Ok Ahn**

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Developing countries have generally come to realize that the availability of technological resources is essential to economic development. Accordingly, they have generated great demand for the transfer of advanced technology in the easiest and fastest way possible. However, because their technological infrastructures are not sufficiently mature to readily absorb such technologies, developing countries have not been able to achieve effective transfer. A technological infrastructure which will both modify and improve imported technology is needed, and can be developed by expanding the network of R&D organizations.

In the early 1960's, Korea's economic growth was achieved through the development of light industry, including the textile, plywood and wig industries. In the face of fierce international competition during the mid-1960's, however, Korea realized that it could no longer enjoy the comparative advantages of cheap labor. The Korean government concluded that the intensive development of science-based, technology-intensive industries, especially the heavy and chemical industries, was necessary for continued economic growth and competitiveness in world markets.

For the transition from light to heavy industry, Korea required advanced technologies from other countries. Because their existing infrastructure was inadequate for prompt absorption, Korean industry was not able to take full advantage of the available technologies. As a result, the Korean Government felt that an integrated research organization was needed to activate R&D* and to play a leading role in the nation's industrialization. Thus the Korea Institute of Science and Technologh (KIST) was established in 1966 as a non-profit, multi-disciplinary research organization. In 1981, KIST merged with the Korea Advanced Institute of Science, a graduate school of science and engineering, to integrate academics and research in one organization. The resulting Korea Advanced Institute of Science and Technology (KAIST), although it is an autonomous

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* Research and Development

juridical person, operates in close cooperation with the Ministry of Science and Technology (MOST).

KAIST, with a research staff of about 1400, is currently conducting more than 100 industrial research projects with a research budget in excess of 10 million U.S. dollars. Its major research fields are : applied chemistry/chemical engineering, polymer science/process engineering, biotechnology/ food technology, materials science/engineering, and electronics and computer science.

1. Government-Sponsored Lump-Sum Contract Research

In developing countries, there are many areas of science and technology which private industries can not or will not undertake research, even though these technologies may be basic to their development. To encourage this research, the Korean government contracts with KAIST to conduct R&D under a lump-sum basis. These lump-sum contracts have recently become more long-term and larger in scale to provide leverage against internal and external competition. These projects can be separated into several categories by their differing goals:

a. those projects that are comprehensive and with strong overall social and national impact,

b. those which require a long period of time before any conclusive results can be expected,

c. those aimed at aiding medium and small scale industries in problems resulting from insufficient capital, inefficient production methods and lack of management know-how,

d. those projects which private enterprises would consider extremely risky because of no immediate return on a massive initial capital investment.

The results of lump-sum in-house contract research must ultimately be used commercially through the licensing or selling of know-how. At the end of 1974, however, the research results had not been effectively commercialized and most had been buried as inventory, even though many could have been commercialized with added efforts. The delay in commercializing R&D results led KAIST to create the Korea Technology Advancement Corporation (K-TAC), as a subsidiary of KAIST, responsible for facilitating the commercialization of R&D results developed at KAIST.

2. Problems in Commercializing R&D Results

In general, for new technology to become productive in an economic sense, it must go through the following stages:

(1) Research, (2) Development, (3) Engineering, (4) Plant Construction, (5) Production and (6) Marketing. It is often misunderstood that a commercially valuable R&D discovery will immediately yield a profit. A frequent case of developing countries is when entrepreneurs fail to recognize that the latter four stages, which require higher investment, effort and patience than does the actual R&D, are indispensable for successful commercialization.

Technologies suitable for development by medium and small enterprises in developing countries are sometimes available. The large corporation of developing countries, of course, can acquire the capacity to commercialize these new technologies by themselves. However, medium and small scale industries are generally discouraged in such activities by the following factors:

a. lack of understanding on the part of entrepreneurs regarding the commercialization of new technology.

b. lack of managerial experience in the process of commercialization,

c. lack of specialists from both internal and outside sources,

d. heavy financial burdens during the plant construction stage, and

e. reluctance of local banks to finance the venture.

3. Establishment of K-TAC

As mentioned, delays in the commercialization of new technologies by Korean industry have made it necessary to establish a special body to facilitate the commercialization process. Consequently in 1974, KAIST invested $60,000 of its own funds in the founding of the Korea Technology Advancement Corporation (K-TAC) as an independent body. Since the steps of commercialization are quite separate from R&D, K-TAC took the form of a private corporation to have mobility and flexibility in operation, as well clearly defined responsibility. Additional investment was planned through the sales of KAIST know-how, with some additional cash infusions by KAIST if necessary.

K-TAC's major activities include the following:

a. commercial promotion of domestic R&D results and foreign technologies,

b. sales of know-how and related support activities,

c. sales of prototype equipment and byproducts resulting from R&D at various laboratories under MOST coordination.

d. R&D project sponsorship,

e. management consulting and other relevant activities.

The decision to accept new technologies for commercialization is made in consideration of the following factors after a comprehensive feasibility analysis has been performed:

a. technology aimed at medium and small scale industry,

b. probability of resulting import substitution and/or export promotion,

c. probability of good financial return (Profit potential).

4. K-TAC's Role in Commercialization

K-TAC accumulates capital in the form of cash and know-how from KAIST and other research laboratories. With this know-how and from other domestic and foreign sources, K-TAC conducts extensive feasibility studies. If a particular study shows promise, K-TAC then draws up a project plan, and recruits potential clients. When the technology is relatively small from business point of view, K-TAC prefers to sell know-how through a licensing agreement providing that the clients are capable of applying the technology involved. When potential clients insist on a profit guarantee rather than a technology performance guarantee, K-TAC provides an equity contribution to demonstrate its faith in the technology. If K-TAC finds that a given technology holds great promise and has a pressing need for commercialization but sees no potential clients, K-TAC may go into business on its own, hoping that interested clients will soon appear. In such cases K-TAC organizes a new business and initiates such commercialization activities as raising funds and constructing a plant.

K-TAC prefers to transfer operations and ownership of its

businesses to private entrepreneurs as soon as these firms have a stable foundation. The revenue generated by these sales are then reinvested in other commercialization projects. Thus, K-TAC's capital could be refered to as a revolving fund. The profits from commercialization are returned to KAIST, KIMM and other shareholders in the form of dividends of research funds.

K-TAC has established a close relationship with the Korea Long Term Credit Bank (KLB) as well as a concurrent cooperative relationship with the Korea Credit Guarantee Fund (KCGF). In addition, K-TAC is supported by the Government via such measures as the Technology Development Promotion Law. These conditions have all contributed greatly to K-TAC's success.

In addition to the commercialization of KAIST's know-how, K-TAC is also currently engaged in technology transfer by exporting the processes and know-how developed at KAIST. Over the years, KAIST has undertaken approximately 2,500 research and development projects. On the average, about half of the projects were sponsored by industry.

A considerable portion of these developments are presently being used by Korean industry. These processes are often suitable for other developing countries due to their appropriate production capacities and optimum process design, and can be competitively exported.

5. K-TAC Performance

K-TAC started with $60,000 in capital and began to seek know-how for commercialization from available KAIST technologies. K-TAC has, since then, been competently performing its duties. It has sold about 2 million U.S. dollars worth of KAIST-generated technology to Korean industries. Some typical items are fluorinated refrigerants, copper plated steel wire, modacrylic

fiber for wigs, antibiotics and agricultural chemicals. Beginning in 1976, K-TAC also created 11 joint venture with the business community in the fields of ceramics, specialty metals, agrochemicals, antibiotics and optical fiber communication. Holdings in three of these companies, were later sold to our partners after the companies attained a stable and profitable position. With the capital thus generated, K-TAC is in the process of creating more companies.

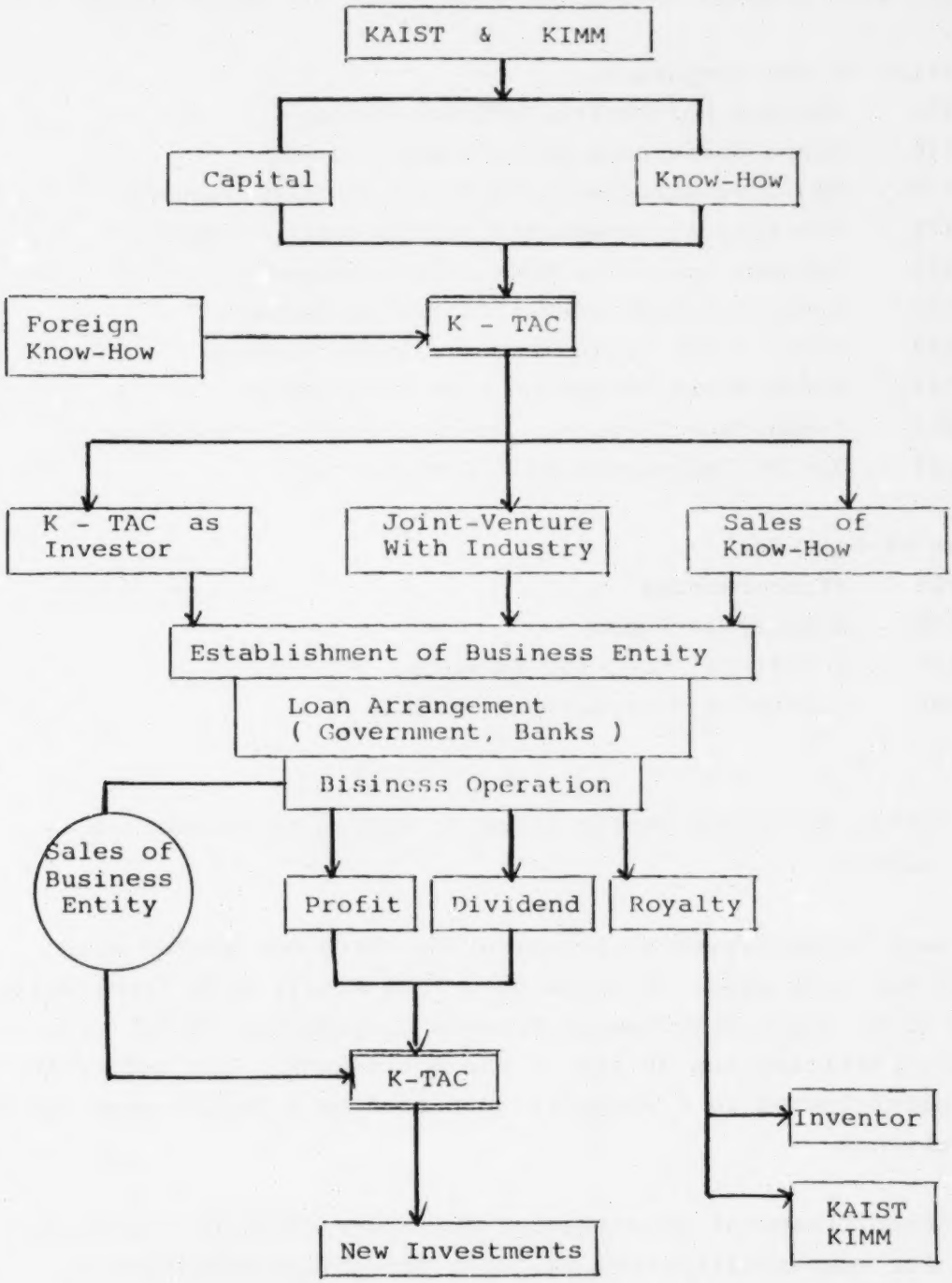
Through its successful operation over the last decade, K-TAC has grown to a corporation with paid-in capital of more than 1.2 million U.S. dollars, and has also become a project development company affiliated with most research organizations under the Ministry of Science and Technology.

6. Strategic Approach to Future Commercialization

K-TAC has accumulated considerable experience through trial-and-error in the commercialization of R&D results since its establishment in 1974. These years may be regarded as the experimental stage (1974-1980) of its operation, since K-TAC confronted many unpredictable problems under unique local business conditions. Most problems occurred during the process of managing capital and originated from a lack of experience rather than from a lack of technological capability. However, the experimental stage can now be considered ended, and K-TAC has entered its next operational stage, which might be called the developing stage (1981-1990). Sound progress in this second stage during the eighties is a prerequisite for the next stage of operation, which could be called the advanced stage (1991 and after), when investment will be aimed at the commercialization of highly sophisticated technologies accompanied by high risk and high potential returns.

As is common in other developing countries, commercialization projects are mainly aimed to decrease Korea's dependence on imports. These import substitution projects, since they have an existing domestic market, are more likely to be successful than those involving entirely new products. K-TAC's activities in the coming years will, therefore, be concentrated primarily on the development of as many import substitution projects as possible. In order to achieve this objective, K-TAC will endeavor to unite technology-based industries from abroad with businesses and entrepreneurs in Korea by offering a wide range of services including technical and managerial assistance : the sale, licensing or purchase of domestic and/or foreign technology, and the establishment of new enterprises based on appropriate technology.

K-TAC's activities are summarized in the following chart.



K-TAC's major performance in the field of industrialization of new tedhnologies during the past years are shown below.

Creation of New Companies

1976	Nam-Hae Cordierite Ceramics Company
1976	Korea Nonferrous Metal Powder Company
1977	Han-Jung Agrochemicals Manufacturing Company
1978	Jin-Hung Agrochemicals Manufacturing Company
1979	Sam-Woo Specialty Metal Wire Company
1980	Yuhan-Antibiotics Manufacturing Company
1982	Korea Fiber Optic Communications Company
1983	Korea Micro Precision Dies Corporation
1983	Kumha Fine Chemicals Manufacturing Corporation
1984	Han-Mi Pharmaceuticals Corporation

Sales of Know-How

1975	Fluorocarbons
1976	Modacrylic Fiber
1979	Artificial Diet for Silkworm
1984	2-Amino-4-Methyl-Benzothiazole

7. Other Financial Institutions to Assist the Commercialization

A best known financial organization which has worked with K-TAC for many years is Korea Long Term Credit Bank (KLB) which used to be Korea Development Finance Corporation (KDFC) with equity participation of IFC of the World Bank. KLB and K-TAC has participated in 6 projects initiated by K-TAC through equity investments.

Another financial organization which was created to provide fund for commercialization is Korea Technology Development Corporation (KTDC). KTDC which was created in 1981 has advanced

loans to the recently launched K-TAC company through partial convertible debentureinvestment.

KTDC provides sponsors of technology development projects with funds in the forms of conditional loans, conventional loans and equity investment. The projects that are eligible for KTDC financing are as follows:

- Research and development activities for the development of new products or new processes and for the improvement of existing products or processes.
- Manufacturing start-up of new products.
- Improvement of production processes to increase productivity, to improve product quality or to reduce cost.
- Purchase of research facilities and equipment and activities related thereto.

In order to perform the above financing activities smoothly, KTDC will secure funds annually at fovorable terms from various sources which include the government, private firms and international financial institutions.

In general, technology development projects are subject to high risk and require a long gestation period, although they may bring about satistafctory returns in case of success. In this connection, KTDC's financing has some unique features which are not normally found in conventional financing.

Besides conventional loans and equity investments, KTDC employs the "conditional loan" program, under which the borrower is responsible for repayment of his obligations to the extent his project has succeeeded. By employing this conditional loan program for the first time in Korea, KTDC

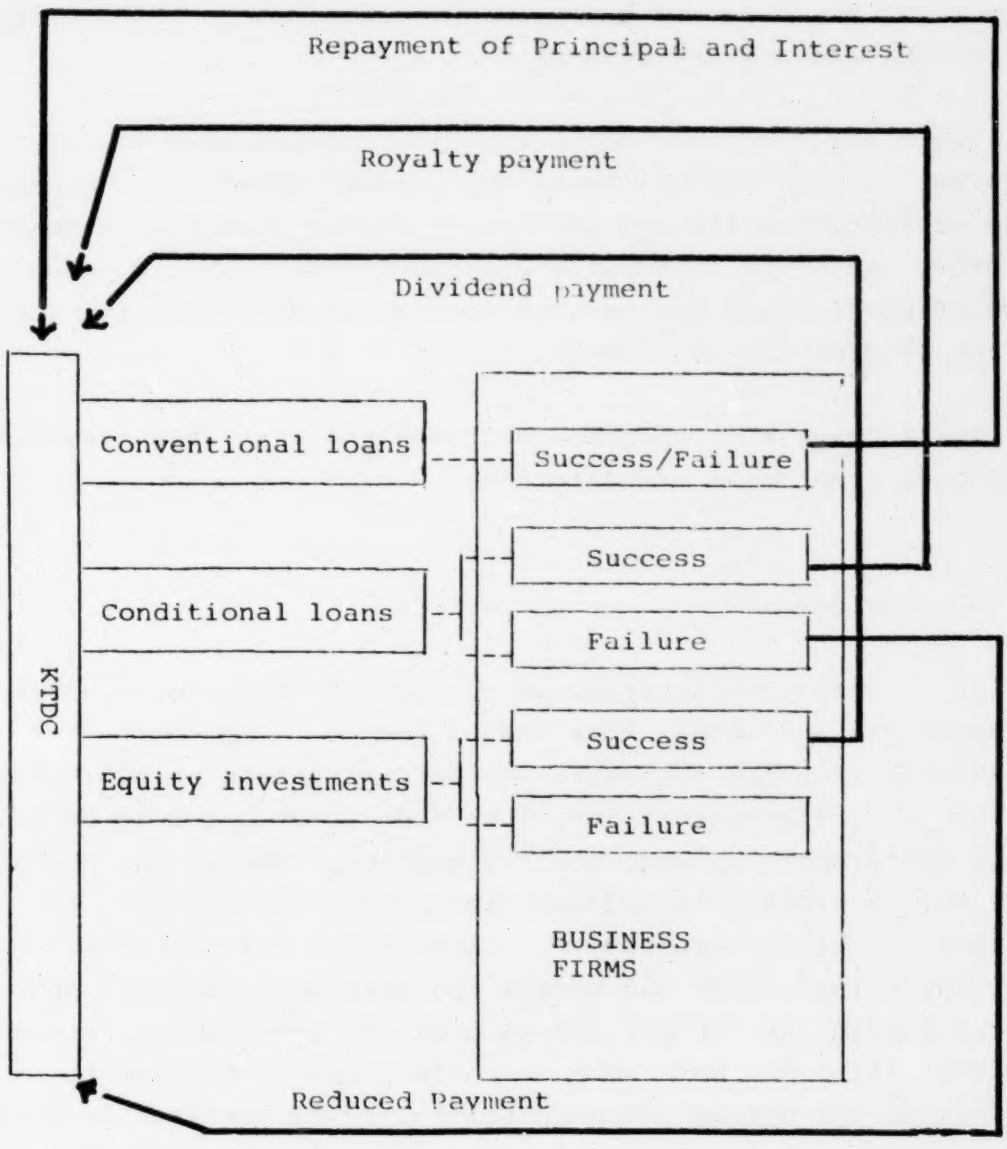
intends to lessen the borrower's burden and to induce more active participation of business enterprises in technology development projects.

By simplifying loan investment procedures to the maximum possible extent, KTDC meets timely the needs of the borrowers for technology development funds.

To ensure a balanced allocation of funds to a variety of technology development projects the following financing limits are maintained by KTDC.

- The maximum financing amount for a single project is limited to ₩500 million.
- The maximum exposure to a single borrower is limited to the amount representing 20% of KTDC's net assets.

KTDC's operational flow is shown below.



It should be emphasized that the basic difference between K-TAC and KTDC has to do with the proactive creation of R&D based company of K-TAC and the reactive banker like loan activities of KTDC. Both activities can be quite complementary since K-TAC has a lot of untapped commercial ideas while either KLB or KTDC has source of funds.

There are two other venture capital companies which are of recent origin. One is Korea Development Investment Company whose shareholders are six short term credit financial companies. The other is Korea Technology Finance Company, wholly owned by Korea Development Bank. These companies are under the jurisdiction of Ministry of Finance.

Researchers with shortage of funds can also seek financial assistance from these organizations.

8. Conclusion

It is well known that close cooperation between research organizations and industry is one of the most important ingredients for the successful commercialization of R&D results. However, the relationship has often been unsatisfactory because of the differences between the two parties. Though the research staff may be highly trained in scientific investigation, it may lack industrial experience. Under these circumstances, K-TAC has helped KAIST and Korean industry to understand and cooperate with each other. Because of the intermediary presence of K-TAC, KAIST has been able to collect needed industrial information and define the required follow-up research to ensure the R&D results in commercial terms. K-TAC has greatly facilitated the commercialization of KAIST's R&D results and, in so doing, has helped industry make significant steps toward implanting high technology in Korea.